REMARKS

The specification is amended to indicate that the term "average molecular weight" should have units of "g/mol", and to improve its form.

Applicants respectfully submit that this amendment should not require further search and is simply being made to resolve an objection to the specification, so entry of the above amendment is respectfully requested.

Claims 1-4, 6-8 and 10-13 are pending, claims 1-4, 6-8, and 10 are rejected, and claims 11-13 are withdrawn.

On page 2 of the Office Action, the specification is objected to as allegedly failing to provide proper antecedent basis for "g/mol."

Applicants respectfully submit that the amendments to the specification obviate this objection, because the specification, as amended, does provide proper antecedent basis for the claims.

Further, Applicants respectfully submit that this amendment does not introduce new matter because it is clear from the specification that "g/mol" is the appropriate unit (for instance ethylene glycol is disclosed at page 7, lines 28-29 in the specification as an example of the organic compound having "a molecular weight of 62" and a plurality of hydroxyl groups, and it is well known that the molecular weight of the ethylene glycol is 62 g/mol).

Reconsideration and withdrawal of the objection to the specification are respectfully requested.

On page 3 of the Office Action, claims 1-8 and 10 are rejected under 35 U.S.C. § 112, first paragraph, as allegedly failing comply with the written description requirement. Namely, the Examiner asserts that claims 1 and 6 have been amended to indicate that the number average

molecular weight of the organic compound is not less than 62 "g/mol" nor more than 300 "g/mol," for which the specification does not provide direct or indirect support.

Applicants respectfully traverse for at least the following reasons.

Initially, Applicants submit that based on the discussion above in connection with the disclosure in the specification (for instance, the molecular weight of the ethylene glycol disclosed at page 7, lines 28-29 is clearly 62 "g/mol"), claims 1-6 are fairly supported by the disclosure in the specification.

Further, Applicants note that in Japan (where the international application leading to the present application was filed), molecular weight can be written as a dimensionless number. In this regard, Applicants attach a portion of a textbook for industrial high school in Japan. This excerpt clearly shows molecular weight as dimensionless.

For example, the molecular weight of water is "18."

It is common knowledge in the chemical arts that the mass of one mol of water almost equals 18 g, such that a person skilled in the art would understand that a number of such a dimensionless molecular weight equals a number expressed by g/mol. Such a number would not be expressed by kg/mol.

Applicants respectfully submit that this knowledge is worldwide common knowledge among chemists, and that it is at least common knowledge in Japan, where the international application for the present application was filed.

Since the present U.S. patent application is based on the international application, such a dimensionless "molecular weight" described in Japanese should be translated into molecular weight as expressed by "g/mol" in the U.S.

Claim 5 is canceled, which renders this aspect of the rejection moot.

Claims 2-4, 7-8, and 10 depend from claims 1 or 6, either directly or indirectly.

Therefore, Applicants respectfully submit that claims 1, 6, and claims dependent thereon do satisfy the requirements of 35 U.S.C. § 112.

Reconsideration and withdrawal of the rejection under 35 U.S.C. § 112, first paragraph, are respectfully requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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For Industrial Chemistry Course of High School

Industrial Chemistry 1

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P.2

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P.3

3. CHEMICAL FORMULAE AND QUANTITIES OF MATERIALS

Atoms and molecules are extremely small. So it is very hard to weigh or react each of them. Generally, it is required to handle a set of numerous atoms or molecules as a unit for substantial measurement and reaction. Here, we learn how such a set of enormous atoms or molecules is expressed in quantity and what units are required.

1 Atomic weight

The mass of an atom is extremely small, for example, about 10^{-26} kg as shown in Table 2-1. Namely, it is too small to be handled as a numeric value. So, let's assume that we use a rate of a mass of each atom (mass ratio) to a mass of a hydrogen atom that is the lightest of all elements (as a value of "1"). The relative masses (mass ratios) of some familiar elements are determined as shown in Table 2-1.

Table 2-1 Masses and mass ratios of atoms

Element name	Mass of a single atom	Mass ratio
Hydrogen		
Carbon		
Oxygen		
Uranium		

Note: A hydrogen atom is the lightest in all elements and a uranium atom is the heaviest in all elements found in nature.

A value representing the mass of an atom (mass ratio) relative to the mass of a certain atom is called an atomic weight. Elements selected as reference atoms have changed with the times as shown in Figure 2-3, but nowadays a carbon atom ${}^{12}_{6}C$ is used as a reference atom and its mass is internationally determined to be 12. Atomic weights approved at international conferences are called as international atomic weight. Atomic weights we usually use are international atomic weights.
Each atomic weight has no unit since the atomic weight of an element is the ratio of mass of the element to mass of a reference element.

P.4

John Dalton (England)
In 1803, he advocated a list of atomic weights of elements relative to the mass of hydrogen (= "1")

Jöns Jacob Berzelius (Sweden)

In 1826, he advocated a list of atomic weights of elements relative to the mass of oxygen (= "100")

Stus (Belgium)
In 1860, he advocated a list of atomic weights of elements relative to the mass of oxygen (= "16")

In 1902, in response to addressing by the German Chemical Society, the International Commission announced an international atomic weight table (including 76 elements) listing atomic weights of elements relative to the mass of oxygen (= "16"). In 1919, the International Union of Pure and Applied Chemistry (IUPAC) was established and kept on announcing international atomic weight tables. In 1961, the International Commission determined to use atomic weights of elements relative to the mass of carbon (= "12").

Figure 2-3 Transition of mass ratio reference elements

Table 2-2 shows atomic weights of some familiar elements. (For more information, see the atomic weights table inside the back cover of this textbook.)

Table 2-2 Samples of atomic weights

Element name	Element symbol	Atomic weight	Rounded atomic weight
Hydrogen			
Carbon			
Nitrogen			
Oxygen			
Sodium			
Sulfur			
Chlorine			
Potassium			
Calcium			

Note: The above atomic weights are respectively rounded to the first decimal place.

The atomic weights are values as of 2005.

One twelfth of the mass of carbon-12 ($^{12}_{6}C$) is defined as one atomic weight unit and expressed by "1u." 1u is $1.66053886 \times 10^{-27}$ kg.

The atomic weight of an element is obtained by multiplying masses of its isotopic atoms in atomic weight units by their abundances (*1). (See Table 2-3.)

*1 See Page 24.

P.5

Table 2-3 Masses of isotopic atoms and atomic weights

Element name	Isotope symbol	Mass of isotopic atom [u]	Abundance of isotope (Ratio of isotopic atoms) [%]	Atomic weight
Hydrogen				
Carbon				
Chlorine				

Note: The mass of each isotopic atom is not an integer because of mass deficiency of atomic nuclei. (See Page 3-14.)
(Cited references: "Chemical enchiridion (Foundation, version 5)" published by the Chemical Society of Japan and "Elements' isotopic composition table" edited by the Subcommittee on Atomic Weights of the Chemical Society of Japan)

The atomic weights are values essential to chemical calculations and, in some cases, they can be rounded to appropriate numbers of decimal places for any purpose. In this textbook, atomic weights are rounded to the first decimal place unless otherwise specified. (See Table 2-2 and the periodic table of elements inside the back cover of this textbook.)

Exercise 5
Calculate atomic weights of some elements from atomic weights and abundances of their isotopic atoms listed in Table 2-3.

2 MOLECULAR WEIGHT AND FORMULAR WEIGHT

1 Molecular weight

A hydrogen molecule consists of two hydrogen atoms and is expressed by H_2. The mass of the hydrogen molecule (H_2) is two times as much as the atomic weight (1.0) of the hydrogen element (H), that is 2.0, by using the same reference as that of the atomic weight. This is called a **molecular weight (molecular weight)** of a hydrogen molecule (H_2).

Similarly, molecular weights of oxygen (O_2) and water (H_2O) can be obtained by calculation from atomic weights of hydrogen (H) and oxygen (O).

Molecular weight of oxygen (O_2): $16.0 \times 2 = 32.0$
Molecular weight of water (H_2O): $1.0 \times 2 + 16.0 = 18.0$

Molecular weights are dimensionless as atomic weights are.

P.6

Hydrogen H (Atom): Atomic weight 1.0
Oxygen O (Atom): Atomic weight 16.0

Hydrogen H_2 (Molecule): Molecular weight $1.0 \times 2 = 2.0$
Oxygen H_2 (Molecule): Molecular weight $16.0 \times 2 = 32.0$
Water H_2O (Molecule): Molecular weight $1.0 \times 2 + 16.0 = 18.0$

Exercise 6
Calculate molecular weights of the following molecules:

Nitrogen N_2 Chlorine Cl_2 Hydrogen chloride HCl Carbon monoxide CO
Carbon dioxide CO_2 Ammonia NH_3 Methane CH_4

文部科学省検定済教科書 7 実教 工業017 高等学校工業科用

工業化学1

実教出版

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3 化学式と物質の量

原子や分子は非常に小さいので，1個ずつ質量をはかったり反応させたりすることはきわめて困難で，ふつうはかなり多数の原子や分子をまとめて取り扱わなければならない。そこで，原子や分子をまとめて取り扱うときの量の表し方や単位が必要になる。

1 原子量

原子1個の質量は，表2-1のように，およそ10^{-26} kgというきわめて小さな値で，数値としては扱いにくい。

そこで，最も軽い原子である水素原子の質量を仮に1と決めると，各原子の相対的な質量(質量の比)は，表2-1のようになる。

表 2-1　原子の質量

元素名	原子1個の質量 [kg]	質量の比
水素	0.1674×10^{-26}	1
炭素	1.994×10^{-26}	11.9
酸素	2.657×10^{-26}	15.9
ウラン	39.53×10^{-26}	236.1

注．水素の原子はあらゆる元素の原子の中で最も軽く，ウランの原子は，天然に存在する元素の原子の中で最も重い。

このように，特定の原子の質量を基準にして，各原子の相対的な質量(質量の比)を表した数値を，**原子量**(atomic weight)という。

原子量の基準としてどの元素の原子を選ぶかは，図2-3のように時代とともに変わったが，今日では炭素原子$^{12}_{6}C$の質量を12とすることが，国際的に決められ~~ている~~る。国際会議で承認された原子量を，**国際原子量**(international atomic weight)という。ふつう，原子量といえば国際原子量のことである。原子量は質量の比であるから

イギリスのドルトン
(1803 年)
水素を 1 とする原子量表を発表

スウェーデンのベルセリウス
(1826 年)
酸素を 100 とする原子量表を発表

ベルギーのスタス
(1860 年)
酸素を 16 とする原子量表を発表

ドイツ化学会のよびかけで，1902 年，国際委員会が酸素を 16 とする国際原子量表を発表(元素 76 種類を含む)。1919 年，国際純正および応用化学連合(IUPAC)が組織され，国際原子量表の発表を続けた。

1961 年には炭素 12 の質量を 12 とすることを決めた。

図 2-3　原子量の基準の移り変わり

単位はない。

表 2-2 に原子量の例を示す(詳しくは裏見返しの原子量表を参照)。

表 2-2　原子量の例

元素名	元素記号	原子量	原子量の概数
水素	H	1.00794	1.0
炭素	C	12.0107	12.0
窒素	N	14.0067	14.0
酸素	O	15.9994	16.0
ナトリウム	Na	22.98976928	23.0
硫黄	S	32.065	32.1
塩素	Cl	35.453	35.5
カリウム	K	39.0983	39.1
カルシウム	Ca	40.078	40.1

注. 原子量の概数は，小数第 1 位に丸めたものである。原子量は 2005 年の値。

$^{12}_{6}\mathrm{C}$ の原子の質量の $\frac{1}{12}$ を 1 **原子質量単位**(atomic mass unit)といい，1 u で表す。1 u は，$1.66053886 \times 10^{-27}$ kg である。

ある元素の同位体の原子の質量を原子質量単位 [u] で表し，それぞれの存在度①をかけて加え合わせると，その元素の原子量になる(表 2-3)。

① p.24 参照。

表 2-3　同位体の原子の質量と原子量

元素名	同位体の記号	同位体の原子の質量 [u]	同位体の存在度(原子の数の割合) [%]	原子量
水素	$^{1}_{1}H$ $^{2}_{1}H$	1.0078 2.0141	99.9885 0.0115	1.00794
炭素	$^{12}_{6}C$ $^{13}_{6}C$	12.0000 13.0034	98.93 1.07	12.0107
塩素	$^{35}_{17}Cl$ $^{37}_{17}Cl$	34.9689 36.9659	75.76 24.24	35.453

注．同位体の原子の質量の値が整数にならないのは，原子核の質量欠損(p.314 参照)の影響である。
(日本化学会編「化学便覧(基礎編 改訂5版)」，日本化学会原子量小委員会「元素の同位体組成表(2001)」による)

原子量は，化学の計算には欠くことのできないたいせつな数値であるが，計算の目的によっては適当なけた数に丸めた概数を用いてもよい。本書では，とくに必要な場合のほかは，小数第1位までの概数を用いる(表2-2 および表見返しの元素の周期表を参照)。

問5　表2-3の同位体の原子の質量と同位体の存在度から，原子量を計算してみよ。

2 分子量と式量

1 分子量

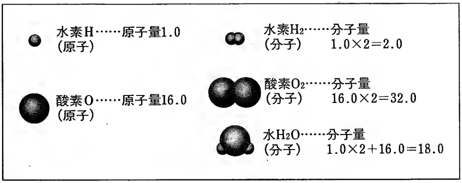
水素の分子は水素原子2個からなりたっていて，H_2 で表される。水素の分子 H_2 の質量を原子量と同じ基準を使って表せば，水素の原子量1.0の2倍の2.0となる。これを水素分子 H_2 の**分子量** (molecular weight) という。

同様に，酸素 O_2 や水 H_2O などの分子量も，水素Hおよび酸素Oの原子量から計算される。

酸素 O_2 の分子量　　$16.0 \times 2 = 32.0$

水 H_2O の分子量　　$1.0 \times 2 + 16.0 = 18.0$

原子量に単位がないのと同様に，分子量にも単位がない。



問6　次の物質の分子量を求めよ。

窒素 N_2　塩素 Cl_2　塩化水素 HCl　一酸化炭素 CO

二酸化炭素 CO_2　アンモニア NH_3　メタン CH_4

2 式量

物質がイオン式や組成式で表される場合，その式の中に含まれる原子の原子量の和を，その物質の式量(formula weight)という。

たとえば，アンモニウムイオン NH_4^+ や硫酸イオン SO_4^{2-} の式量は，次のように計算される。[①]

NH_4^+ の式量　$14.0 + 1.0 \times 4 = 18.0$

SO_4^{2-} の式量　$32.1 + 16.0 \times 4 = 96.1$

また，塩化ナトリウム NaCl や塩化マグネシウム $MgCl_2$ の式量は，次のようになる。

NaCl の式量　$23.0 + 35.5 = 58.5$

$MgCl_2$ の式量　$24.3 + 35.5 \times 2 = 95.3$

金属(たとえば鉄，銅など)は，それぞれ1種類の元素の原子でできている単体であって，分子は存在しない。金属の元素記号(Fe, Cu など)は原子記号であると同時に組成式であって，それぞれの原子量(Fe は 55.8，Cu は 63.5)が式量にあたる。

① イオンの場合，厳密には電子の増減による質量の変化を考えに入れる必要があるが，電子の質量は原子の質量に比べてきわめて小さいので，概数を用いる計算では，その変化は無視してよい。